Cardno ChemRisk
Shaping the Future

April 29, 2014

Ms. Jean A. Mescher, Project Coordinator
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One Post Street, 34th Floor
San Francisco, CA 94104

Subject: **Revised Conceptual Site Model and Proposed Decision Unit Plan for the Arkwood, Inc. Site, Omaha, Arkansas; EPA ID# ARD084930148; Site ID: 0600124**

Dear Ms. Mescher:

This letter report provides a proposed conceptual site model (CSM) for the Arkwood, Inc. site ("Site") in Omaha, Arkansas. The CSM addresses polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (PCDD/Fs) to evaluate risk assessment compliance of the remediated Site given recent changes in the toxicity criteria for 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) (IRIS, 2012; USEPA, 2009). A summary of 1995 post-excavation sampling data and 2012 sampling data is presented and utilized to develop "decision units" (DUs) for the Site. In addition, we have proposed an approach for further soil sample collection to confirm PCDD/Fs concentrations for the decision units. The USEPA (2011) guidance for incremental composite soil sampling for PCDD/Fs was utilized to develop a set of 7 areas that will be designated as separate DUs, each of which will be sampled using an the incremental sampling methodology (ISM) and 1 – 7 composite samples of 30 to 40 increments will be collected from each DU, depending on its size and the expected heterogeneity of the PCDD/F concentrations in the DU. These composite samples will be considered the representative soil concentration for each DU and will be used to evaluate risk assessment compliance for PCDD/Fs at the Arkwood, Inc. Site by comparing the maximum composite measurement for each DU to the dioxin soil screening level of 665 ppt TEQ.

Conceptual Site Model Information

According to USEPA (2011) guidance, a CSM pertaining to PCDD/F soil concentrations at the Arkwood Inc. Site should contain appropriate historical information regarding the past activities and information relevant to sources, transport pathways, and completed exposure routes that may be relevant to current and future site operation and use conditions. Accordingly, in the attached figures and tables we have provided the information which characterizes the relevant parameters based on available documents and data resources. The site history information is contained in the EPA online information for the Site and was used to develop the CSM. The post-excavation sampling data and site characteristics that define potential soil exposure routes for risk assessment purposes are presented in this report.

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Topographic maps were obtained from USGS/Google Maps identifying the steep terrain surrounding the Arkwood Inc. Site, which was a plateau carved out from adjacent hillsides surrounding most of the site perimeter. Figure 1 identifies the perimeter of the site in reference to the topographic features. Figure 2 illustrates that the plateau comprising the Site is bordered by contiguous uphill gradients on approximately three quarters of the site perimeter. Only on the northwestern section of the site perimeter is there a downhill gradient that descends approximately 12-15 feet down to a flat area adjacent to the railroad tracks; this ditch area gradually slopes towards the railroad tunnel in an easterly direction. A bird's eye aerial photograph taken at the western edge (main entrance) of the site in Figure 3 illustrates that the plateau of the site gradually slopes towards the entrance at an approximate grade of 5 to 10 degrees that promotes sheet flow of rainwater across the vegetated main Site. In 1994, prior to any remedial work at the Site, the stormwater drainage ditches were constructed along the perimeter of this section of the site near the current fenceline of the facility. The fenceline is at the top of the slope that descends toward the railroad ditch area at an approximate grade of 45-60 degrees. The surface water flow during rain events drains towards the Site entrance and is intercepted by the stormwater ditches on the north, south and west edges of the Site. The two onsite drainage ditches meet at the natural berm area beside the main entrance road just beyond the confluence of the main road and the former haul road that turns off to the right (south). This Site configuration provides for percolation of rainwater within the stormwater ditches except in extreme rain events when overflow of the ditches can lead to excess stormwater release at the natural berm area that flows down to the adjacent railroad ditch area.

Figure 4 provides an overview of the former excavated zones (within the black outlines) and the areas of the Site that were subsequently graded and capped (within the blue outlines). The capped zone extends over approximately 82% of the Site surface area and completely covers the formerly excavated zones up to the building foundation and up to the drainage ditches (Figure 4). Notably, the eastern-most area of the site was not used for storage or processing of treated wood and thus may be considered a background zone. Likewise, the western-most triangular area at the main entrance was not used for storage or processing of treated wood. However, the remainder of the Site was graded and covered with a 6-inch clean cap per the USEPA-approved remedial design in 1995.

Table 1 provides a summary of post-excavation confirmation soil sampling for PCDD/Fs conducted at the Arkwood Inc. Site in 1995 prior to final grading and installation of a 6-inch clean soil cap. These data are overlaid on the Google Map photo of the Site in Figure 5, showing the location and concentration ranges reported in 1995 as TCDD Toxicity Equivalents (TEQ) using the concurrent International- TCDD Toxicity Equivalence Factors (I-TEF) approach. Table 1 illustrates that based on ditch soil PCDD/F samples obtained in 2012, the I-TEF approach overstates the most current EPA-endorsed approach by the World Health Organization (WHO 2005 as adopted by USEPA, 2010) by an average factor of 1.28. The post-excavation sampling data expressed in the current TEF scheme indicates an average TEQ concentration of 5.85 ± 3.77 ppb (mean/SD) beneath the capped soil zone based on 37 composited samples from the excavation zones. The cap soil was obtained from a reportedly clean site excavation from Harrison, AR, but no soil PCDD/F measurements of this material were found in the available records. We understand that the stormwater drainage ditches surrounding the formerly operating portions of the Site were installed in 1994, prior to any excavation, grading and capping of the Site. The 6-inch cap soil does extend to the edge of the ditches onsite.

Figure 6 provides a summary diagram of the CSM for risk assessment purposes, assuming industrial use in the future for the Site, the adjacent railroad ditch area, and New Cricket Spring. PCDD/Fs in soil from the areas affected by former processing and/or storage of treated wood materials are considered the main source, although some residual contamination in the drainage ditches and uncapped areas may have been deposited prior to or during the Site closure activities in 1995. The capped area is not expected to be subject to any substantial current or future PCDD/F contamination based on the origin of the soil used for capping and the cap performance since installation. Based on the current Site configuration, the only offsite transport pathways would include stormwater and associated sediment flowing into the onsite drainage ditches or down to the railroad ditch during exceptionally heavy rain events. All stormwater draining from the capped areas of the site is captured by the drainage ditch system, and there has been no history of erosion events or other ditch or cap failure. Accordingly, sediment PCDD/F transport creates a plausible completed exposure pathway for both onsite workers and, for offsite trespassers, contacting the railroad ditch area. The direct soil exposure pathways for PCDD/Fs onsite and offsite include incidental soil ingestion and dermal contact.

The inhalation pathway is included but it is considered negligible relative to the direct soil ingestion and dermal contact pathways since the contaminated areas of the Site have been capped and fully vegetated; therefore, appreciable dust release is not plausible (Paustenbach et al. 2006). The surface water pathway is excluded since there is no seasonal or permanent body of water onsite or in the railroad ditch area. Likewise, the groundwater transport pathway, while included, is considered incomplete due to the insoluble nature of PCDD/Fs and the sedimentation/filtration effects of the karst geologic structure underlying the Site. Finally, there are no plausible future residential uses of the Site in accordance with the ROD and deed restriction and the Site uses do not disturb the integrity of the Site cap and drainage systems.

Table 1. Summary of 1995 and 2012 PCDD/F Sampling Results for the Arkwood Site.

Sampling Event	Sample ID	Cells Included In Composites[a]	I-TEF TCDD TEQ Concentration (ppb)	WHO 2005 TCDD TEQ Concentration (ppb)
1995	Cell 1	Cells 1, 9, 10, 11	8.5	***6.65***
1995	Cell 2	Cells 2, 3, 4, 5, 6, 7	4.7	***3.70***
1995	Cell 2	NA	8.8	***6.86***
1995	Cell 3	Cells 2, 3, 4, 5, 6, 7	4.7	***3.70***
1995	Cell 3	NA	10.2	***7.92***
1995	Cell 4	Cells 2, 3, 4, 5, 6, 7	4.7	***3.70***
1995	Cell 4	NA	12.9	***10.02***
1995	Cell 5	Cells 2, 3, 4, 5, 6, 7	4.7	***3.70***
1995	Cell 5	Cells 5, 6, 7	11.8	***9.20***
1995	Cell 6	Cells 2, 3, 4, 5, 6, 7	4.7	***3.70***
1995	Cell 6	Cells 5, 6, 7	11.8	***9.20***
1995	Cell 7	Cells 2, 3, 4, 5, 6, 7	4.7	***3.70***
1995	Cell 7	Cells 5, 6, 7	11.8	***9.20***
1995	Cell 8 (Floor)	NA	0.25	***0.20***
1995	Cell 8 (Walls)	NA	0.25	***0.20***
1995	Cell 8	Cells 8, 9, 11	16.8	***13.1***
1995	Cell 9	Cells 1, 9, 10, 11	8.5	***6.65***
1995	Cell 9	Cells 8, 9, 11	16.8	***13.1***
1995	Cell 10	Cells 1, 9, 10, 11	8.5	***6.65***
1995	Cell 10	NA	11.5	***8.96***
1995	Cell 11	Cells 1, 9, 10, 11	8.5	***6.65***
1995	Cell 11	Cells 8, 9, 11	16.8	***13.1***
1995	Cell 12	Cells 12, 13	9.2	***7.21***
1995	Cell 13	Cells 12, 13	9.2	***7.21***
1995	Cell 14a	Cells 14a, 14b, 14c, 15b	7.4	***5.76***
1995	Cell 14b	Cells 14a, 14b, 14c, 15b	7.4	***5.76***
1995	Cell 14c	Cells 14a, 14b, 14c, 15b	7.4	***5.76***
1995	Cell 15a (Floor)	NA	1.4	***1.12***
1995	Cell 15a (Walls)	NA	3.9	***3.04***
1995	Cell 15b	Cells 14a, 14b, 14c, 15b	7.4	***5.76***
1995	Cell 16 (Ashpile)	NA	0.22	***0.17***
1995	Cell 16	NA	1.4	***1.12***
1995	Cell 17 (Sinkhole Floor)	NA	0.49	***0.38***
1995	Cell 17 (Sinkhole Walls)	NA	3.1	***2.39***
1995	Cell 18 (Railroad) (Floor)	NA	1.0	***0.80***
1995	Cell 18 (Railroad) (Walls)	NA	11.0	***8.56***
1995	Cell 18	NA	14.8	***11.5***
2012	Sample 1	NA	0.42	0.33
2012	Sample 2	NA	2.0	1.60
2012	Sample 3	NA	0.61	0.47
2012	Sample 4	NA	0.43	0.32
2012	Sample 5	NA	0.52	0.39
2012	Sample 6	NA	0.052	0.043

a For composite cell samples, TEQs are representative of all of the cells in the composite.

Bold/Italics values: Because congener-specific data were not available for the 1995 samples, the WHO 2005 TCDD TEQ values were estimated by multiplying the I-TEF TEQ concentration by a factor of 0.78, the average for the 6 samples collected in 2012 that had full congener-specific PCDD/F profiles.

Proposed Decision Unit Plan

Figure 7 provides an overview of seven proposed areas corresponding to "decision units" (DUs) at this Site in accordance with USEPA (2011) guidance. Table 2 presents a summary of each DU, its surface area, the expected level of PCDD/F concentration heterogeneity, the number of incremental samples to be collected, and overview of the sampling approach for each DU. All of the proposed samples will be surface soil samples collected from 0-2 inches in depth.

DU #1 (Uncappped Area East) is the uncapped eastern section of the site where no treated wood storage or processing activities were conducted based on available information and is shown in detail in Figure 8. Because this DU is approximately 1.2 acres in area, it will be divided into 5 sampling units (SU) of 0.25 acres each. Two of the SU will be randomly selected and an incremental sample of 30 increments will be collected from each selected SU. The heterogeneity in PCDD/F concentrations is expected to be low to moderate in this area due to the lack of past site activity.

DU #2 (Capped Area) is the capped area of the site that covers all of the formerly excavated areas; this will determine if there is any evidence of cap contamination that occurred during cap installation or due to cap breach after installation in 1995. This DU is shown in detail in Figure 9. This DU is the largest DU covering 82% of the site with an area of 11 acres. Because of its size, this DU will be divided into 44 SU of approximately 0.25 acres each and five SU of the 44 will be randomly selected for sampling. A single incremental sample of 30 increments will be collected from each of the four selected SU while three incremental samples of 30 increments each will be collected from the fifth selected SU. The heterogeneity in PCDD/F concentrations in this area is expected to be low given that the soil will be from the clean cap.

Figure 10 illustrates DUs #3 (Stormwater Ditch North) and #4 (Stormwater Ditch South). DU #3 is the northern perimeter ditch area spanning from the natural berm area on the western side of the Site to the northeastern-most perimeter adjacent to a formerly excavated and capped area. This DU is approximately 0.14 acres in area and 467 m in length. This DU will be divided in half lengthwise into two SU of approximately 233 m. One incremental sample of 40 increments will be collected from each SU. The increments will be collected from the bottom of the ditch approximately every 6 m along the length of the DU. DU #4 is the southern perimeter ditch area that also spans from the natural berm area on the western side of the Site to the southeastern-most perimeter adjacent to a formerly excavated and capped area. This DU is approximately 0.17 acres in area and 560 m in length. This DU will be divided in half lengthwise into two SU of approximately 280 m. One incremental sample of 40 increments will be collected from each SU. The increments will be collected from the bottom of the ditch approximately every 7 m along the length of the DU.

DU #5 (Berm Area) is the sedimentation zone and basin (natural berm area) formed by the confluence of the north and south perimeter ditches; this is the area where 2012 sampling events (independent samples, not composites) revealed soil concentrations of 328 ppt and 1,600 ppt TEQ. This DU is shown in Figure 11. This DU is bounded to the north by the fenceline and to the south by the road. The western boundary of the DU is set 10 ft from the location of the 1,600 ppt TEQ sample and the eastern boundary is set 50 ft from the same sample. The area of this DU is approximately 12 ft x 60 ft (0.02 acres). One incremental sample of 30 increments will be collected from this DU.

Figure 12 shows DU #6 (Uncapped Area West), which is the uncapped area of the site between the entrance and the capped area (DU #2). This DU is about 1 acre in area and will be divided into 4 SU of approximately 0.25 acres each. One of the SU covers the area of the former truck decontamination pad where truck tires were washed before material from the site was hauled off-site during the remediation of the Site. Because there might a higher level of heterogeneity in this area, this SU will be sampled using one incremental sample of 30 increments and one of the other three SU will be randomly selected and sampled using one incremental sample of 30 increments.

Figure 13 identifies DU #7 (Railroad Ditch) corresponding to the railroad ditch area that receives stormwater overflow from the natural berm area of the site during exceptionally heavy rain events. This railroad ditch area is a relatively flat zone immediately downhill from the natural berm area and adjacent to the railroad tracks, with a slight grade eastward towards the railroad tunnel. Sampling over a the span of this ditch area from the natural berm area to the railroad tunnel using the incremental composite sampling approach will evaluate offsite PCDD/F transport that might have occurred. This DU is bound to the south by the bottom of the hillside and to the north by the railroad track ballast. The western boundary for this DU is 20 ft west of the 1,600 ppt TEQ sample and the eastern boundary is 460 ft from the same sample and is the end of the former railroad ditch excavation area. One incremental sample of 30 increments will be collected from this DU.

Table 2. Summary of the Sampling Approach by Decision Unit[a].

Decision Unit Name	Surface Area (acres)	Expected Heterogeneity	Expected Distribution of Increments	Number of Incremental Samples	Number of Increments	Description
DU 1 Uncapped Area East	1.2	Low to Moderate	Lognormal	2	30	DU will be divided into 5 SU of 0.25 acres. 2 SU will be randomly selected. 1 incremental sample of 30 increments will be collected from each selected SU. Heterogeneity expected to be low to moderate due to the lack of past site activities in this area.
DU 2 Capped Area	11	Low	Normal	7	30	DU will be divided into 44 SU of 0.25 acres. 5 SU will be randomly selected. 1 incremental sample of 30 increments from 4 SU. 3 incremental samples of 30 increments from 1 SU. Heterogeneity expected to be low because sampled soil will be from the clean cap.

DU 3 Stormwater Ditch North	0.14	Moderate	Lognormal	2	40	Ditch is divided evenly into 2 SU of approximately 233 m in length. 1 incremental sample of 40 increments to be collected from each SU. Increments will be collected from the bottom of the ditch approximately every 6 m over a combined length of 467 m.
DU 4 Stormwater Ditch South	0.17	Moderate	Lognormal	2	40	Ditch is divided evenly into 2 SU of approximately 280 m in length. 1 incremental sample of 40 increments to be collected from each segment. Increments will be collected from the bottom of the ditch approximately every 7 m over approximate combined length of 560 m.
DU 5 Berm Area	0.02	Moderate	Lognormal	1	30	DU is bounded to the north by the fenceline and to the south by the road. DU boundary to west is 10 ft from 1,600 ppt TEQ sample and boundary to the east is 50 ft from the same sample. 1 incremental sample of 30 increments.
DU 6 Uncapped Area West	1.0	Low to Moderate	Lognormal	2	30	DU will be divided into 4 SU of 0.25 acres. 1 incremental sample of 30 increments from truck decontamination area (area closest to capped area). 1 SU of 3 remaining will be randomly selected for 1 incremental samples of 30 increments .
DU 7 Railroad Ditch	0.06	Low	Lognormal	1	30	DU is bounded to the south by the bottom of the hillside and to the north 5 ft from railroad track ballast. DU boundary to the west is 20 ft from 1,600 ppt TEQ sample and to the east is 460 ft from the same sample to the end of the former railroad ditch excavation area. 1 incremental sample of 30 increments.

[a] All samples will be collected from 0-2 inches from the surface.

Conclusions

The CSM proposed for the Arkwood Site addresses polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (PCDD/Fs) to evaluate risk assessment compliance of the remediated Site given recent changes in the toxicity criteria for 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) . The CSM proposed for the Arkwood Inc. Site is based on historical activities, available analytical data and site conditions. A total of 7 DUs are identified for the Site. These DUs were developed and will be sampled following EPA guidance to confirm PCDD/Fs concentrations. The results for each DU will be used to evaluate risk assessment compliance for PCDD/Fs at the Arkwood, Inc. Site.

After the EPA approves the proposed CSM, a work plan detailing the sampling methods and analytical procedures will be prepared and submitted for agency approval.

Signed,

Brent D. Kerger

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Senior Principal Health Scientist	President and Managing Principal

References

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USEPA. 2011. User Guide. Uniform Federal Policy, Quality Assurance Project Plan Template for Soil Assessment of Dioxin Sites, September 2011 U.S. Environmental Protection Agency, Washington, DC.

Attachment A to McKesson's Revised Site Conceptual Model and Decision Unit Plan (Cardno ChemRisk, April 30, 2014)

Cardno ChemRisk responses to comments from: Jon Rauscher, Ph.D., USEPA

Comments:

1. *Page 4, Conceptual Site Model Information: The inhalation exposure pathway is likely to be negligible but the pathway should not be excluded from the conceptual site model (CSM). The inhalation pathway at a minimum should be addressed qualitatively and the necessity for a quantitative examination of the pathway should be reevaluated after the site visit.*

   The surface water and groundwater exposure pathways were excluded from the CSM. The exclusion of the surface water and groundwater pathways may need to be addressed after the examination of dioxin soil levels.

RESPONSE: All possible exposure pathways have now been included in the CSM figure.

2. *Page 6, Proposed Decision Unit Plan: Decision Unit (DU) #1 was suggested as an area that likely represents background concentrations of polychlorinated dibenzo-p-dioxin and dibenzofuran (PCDD/Fs). Generally on-site areas are not considered to represent background concentrations. The use of DU #1 as the background or reference concentration should be reexamined after the site visit. Due to the size of DU #2, DU #2 may need to be divided in units of smaller size DUs. Whether DU #2 needs to be subdivided should be reevaluated after the site visit. The appropriateness of all of the proposed DUs should be reevaluated after the site visit.*

RESPONSE: Per our responses to comments from Deanna Crumbling of USEPA, we will be sampling the uncapped areas of the site using a statistical sampling approach designed to determine whether any of the DUs investigated show a composite maximum value that exceeds the dioxin soil screening level of 665 ppt TEQ. Determination of background is not relevant here, and we have removed that description from DU#1.

3. *Page 7, Conclusions: As the work plan is being prepared by McKesson and their contractor, they should consider the comments provided by EPA Headquarters.*

RESPONSE: Done.

Cardno ChemRisk responses to comments from: Deana Crumbling, USEPA

General Comments

1. *There are several things that need to be known before a sampling design can be developed. A risk assessor needs to be involved in answering these questions.*

   a. *How will the data be used?*
      i. *Will the data be used to estimate exposure concentrations (EPC) to calculate actual risk? OR*
      ii. *Will the decision unit (DU) data be compared to a threshold value already determined to represent acceptable risk?*
         1. *This is the more desirable option from a sampling design perspective.*
         2. *If so, what is that threshold value?*

      iii. *What will be the statistical value used as the EPC?*
         1. A mean for an exposure unit (EU)? OR
         2. A 95% upper confidence limit (UCL) on the mean for an EU?

   b. *What is the area and depth of the EU (in terms of sq.ft. or acres (for area), and inches (for depth)]?*

RESPONSE: The data will be used to determine whether any of the DUs investigated show a composite maximum value that exceeds the dioxin soil screening level of 665 ppt TEQ. The depth of each EU will correspond to the sampling depth of 0-2 inches below ground surface.

2. *Once the above are decided, some more things need to be considered to develop the design:*
   a. *What is the likelihood that the results will be:*
      i. much lower than the threshold,
      ii. close to the threshold, or
      iii. greater than the threshold?
         1. *influences how many increments and how many replicate field incremental samples (ISs) are needed to achieve statistical goals*

   b. *How much dioxin concentration variability is likely present at the scale of the increments' sample support (soil mass in grams)?*
      i. influences number of increments for DU sizes larger than the standard ¼-to ½ acre for which 30 increments are usually enough

   c. *What is the likelihood that the data will show a normal vs. non-normal distribution?*
      i. *influences what type of UCL is used, which influences number of increments and number of replicate ISs needed to meet statistical goals*

RESPONSE: Except for the berm area (DU#5), we don't expect significant heterogeneity within any of the other sampling areas with respect to the composite maximum being below the dioxin soil screening level of 665 ppt TEQ. Table 2 in the revised Conceptual Site Model and Decision Unit Plan submitted herewith provides a summary of our estimates of surface area for each of the DU and SU sections, and our expectations for heterogeneity. Notably, the largest DU (DU#2), with an 11-acre surface area comprising about 82% of the site surface area, is expected to have uniformly low soil dioxin concentrations because we are sampling the clean cap material.

3. The target particle size for the soil samples needs to be decided (i.e., all particles less than 2 mm? or only a finer particle fraction?). This is determined by the exposure pathway.

RESPONSE: We believe that the < 2 mm fraction should be sufficient for evaluation of dermal contact and ingestion pathways most relevant to the dioxin soil screening level.

4. Handling of non-detect congeners (when calculating the TEQ) needs to be agreed upon.
   a. EPA can provide an automated Excel-based calculator that aids TEQ calculation and documentation.

RESPONSE: We don't expect detection limits to be an important issue in determining compliance with the 665 ppt TEQ dioxin soil screening level because we expect the detection limits should be much lower than 665 ppt on a TEQ basis –most likely 1 ppt or lower. If necessary, we will utilize half the detection limit as a surrogate value.

Specific Comments

1. The considerations above are not discussed in the CSM document, therefore the basis for developing a sampling design is currently lacking.

2. The areas of proposed DU1 and DU2 were not provided. I did coarse estimates from older maps with a scale bar in the 2012 report.

   a. DUI is probably about 1 acre.
      i. DUI is portrayed as "background" because it is assumed that no activities took place there. However, this land is adjacent to areas where contamination had to be excavated.
         1. Unless there is a physical barrier present, such as a wall, it would be surprising if contamination stopped abruptly at the boundary between DUs 1 and 2.
         2. Old spills of creosote or deposition of contaminated ash or soil/dust are possible, even if there is no record of it.
         3. This would create high contaminant heterogeneity, which would require more than 30 increments.

ii. *Splitting DU1 into 2 DUs or 2 SUs (one adjacent to the main site, and the other at the other end) may be advantageous.*
   1. DUs are the soil volume upon which a decision is made [such as an exposure unit (EU) or a remediation unit].
   2. The SU term is used when it is advantageous to split up a single DU into smaller areas. Each SU is sampled with at least 1 incremental (≥ 30 increments) or composite (<30 increments) sample.
      a. Large EUs may be split into SUs in order to ensure adequate increment density, or to maintain spatial information about contaminant location to inform remedial design.
      b. IS data from the SUs are combined statistically to produce the EU/DU value that is used for comparison to a threshold.
      c. Individual SUs are cleaned up ONLY if the entire DU exceeds the threshold.

iii. *If the SU/DU closest to the main site exceeds the decision threshold, it can be cleaned up separately from the SU/DU farther away.*
iv. *The number of replicate ISs per DU need to be considered in order to serve the following purposes:*
   1. Evaluating whether increment numbers were adequate;
   2. Obtaining a representative mean; or
   3. Calculating a UCL.

b. *DU2 appears to be between 4 and 5 acres. This is much too large for a single DU using the default of 30 increments per DU.*
   i. *Strategies to split up DU2 into smaller DUs [or possibly sampling units (SUs)] need to be discussed.*
   ii. *The numbers of increments and replicate ISs per new DU/SU need to be considered while keeping in mind the topics under "General Comments."*
   iii. *There is considerable flexibility in ICS designs.*

RESPONSE: We have omitted reference to "background" since DU#1 is believed to be the uncapped site area that was not used for storage or processing of wood treatment chemicals during past facility operations. As indicated in the revised sampling plan, we have segregated another DU (DU#6), which is an approximately one acre area on the western side of the site, from the original DU#2 (capped) because it is uncapped and part of it was used for truck decontamination during the remediation. There is no evidence or history to suggest that spills or ash deposition affected other areas of the remainder of DU#2. We also propose to divide DU#1 (uncapped), which is approximately 1.2 acres, into ¼ acre sections and randomly select 3 of those sections for sampling. For DU#2 (capped), we also propose to divide it into 44 quarter acre SUs and randomly select 5 SUs for sampling.

3. DU3 north ditch, about 1000 ft long. During site visit, select a 300 ft. length where the terrain is flattest and where the most percolation occurs. Stagger increments (alternate left & right sides *of ditch bottom) with 1 increment per 10 ft. Sampling of the sides of the ditch should not be done. The number of replicates (if any) should be decided with justification.*

4. DU4 south ditch, about 1200 ft long. As DU3.

RESPONSE: We propose to divide the north (DU#3) and south (DU#4) drainage ditches into 2 SUs that will be sampled approximately every 15 feet (n = 40 sub-samples) to obtain two composite samples for each ditch.

5. DU5 berm area, probably a small area (< ¼ acre?). If so, 30 increments per IS are probably ok. The number of replicates (if any) should be decided with justification.

RESPONSE: DU#5 is approximately 0.02 acres. We propose to collect one composite sample of 30 subsamples in this small area to obtain a representative value.

6. DU6 RR ditch. If small, 30 increments per IS are probably ok. The number of replicates (if any) should be decided with justification.

RESPONSE: Because of the addition of another DU (DU#6: Uncapped Area West), this DU is now DU#7 and is approximately 0.06 acres. We propose to collect one composite sample from 30 subsamples collected in this small area to obtain a representative value.

7. There was no discussion of sampling quality control (QC). Refer to Figure 4, page 38 of the Dioxin UFP-QAPP User Guide.

a. Adequate QC data are needed so that data analysis can determine the degree of data variability attributable to field heterogeneity, sample handling & subsampling, and the analytical instrument.

b. A laboratory must be found that has the equipment and skills to process and subsample the ISs.

c. Processing IS samples in the field is possible if the preferred lab does not have the ability to manage sampling error. This would require a properly trained field team.

RESPONSE: We propose to collect triplicate samples for one of the 5 SUs randomly selected from the capped area (DU#2) in order to evaluate variability and QC data. The sampling workplan will be submitted separately from the CSM document and will contain the QAPP and chosen laboratory and field team information for your input.

8. Recommend that the Dioxin UFP-QAPP template be used to ensure that sampling and analytical method selections and respective QC are adequately planned and described.

RESPONSE: This information will be provided with the sampling workplan and QAPP.

9. A pilot project should be considered before "putting all the eggs" in 1 field mobilization basket. The pilot can "kill several birds with 1 stone"

a. Resolve uncertainties and test critical assumptions underlying DU delineation and numbers of increments and replicates

i. Allow refinements to the sampling design to reduce costs

ii. For example, if it is found that concentrations are much lower or much greater than the decision threshold, the number of increments and replicates might be minimized for the main sampling event.

b. Ensure that the field team knows how to collect field ISs correctly and institute corrective actions (if needed) for the main sampling event; and

c. Ensure the laboratory (or field team) can process ISs and perform incremental subsampling correctly (as measured by replicate subsamples) and institute corrective actions (if needed) for the main sampling event.

RESPONSE: Based on the historical information and ditch soil data collected to date, we anticipate most if not all areas will have concentrations lower than the dioxin soil screening level as 82% of the site is covered with clean cap material and most other areas were not used for wood treatment chemical storage or processing during the historical use of the site. Additional sampling and remediation, if needed, will be conducted to assure compliance in any area that exceeds the decision threshold concentration.

Cardno ChemRisk responses to comments from: Ghassan A. Khoury, MSPH. Sc.D., USEPA

The Conceptual Site Model and Proposed Decision Unit Plan for the Arkwood. Inc. Superfund site was reviewed and the following are my comments.

1. It is reported that Figure 6 provides a summary diagram of the CSM assuming industrial use in the future for both the Site and the adjacent railroad ditch area.

The potential development of an industrial complex in the future on any portion of the Site is not properly addressed. A 6 inch soil cover cap over dioxin contaminated soil will not preclude digging out the contaminated soil and spreading it over the surface when an industrial complex is built in the future. All post-excavation confirmation soil sampling for dioxin, except for one sample, conducted at the Site in 1995 prior to final grading and installation of a 6-inch clean soil cap exceeded the soil preliminary remediation goal (PRG) for dioxin of 0.665 ppb for a worker scenario. A risk assessment need to be developed irrespective of any institutional controls where by dioxin levels found at 6 inches and below are used as an exposure point concentration for a future worker land use scenario. After determining risk to a worker, then risk management decision will be made as to whether future industrial land use is suitable or further remediation is needed or claim the land unsuitable for future industrial land use development.

RESPONSE: We understand that the "dioxin reassessment" requested by EPA is a query as to whether or not the Arkwood site, which is in post-remediation, capped, and monitored/ maintained status, complies with the dioxin soil screening level of 665 ppt TEQ. There is now or soon will be a rigorous deed restriction recorded on the relevant portion of the site's title by its owner that: limits future use to industrial; prohibits activities that disrupt the integrity of the cap; and prohibits digging in the capped area (DU#2) unless prior written approval is obtained from USEPA, in consultation with ADEQ, based upon the prior submittal of a proposed excavation plan.Thus, there is no question that the future site use, if any, will be industrial, that it will continue to be monitored, and that its engineering controls (i.e. fencing, partial site cap) will be maintained, for many more years. If and when any industrial development is proposed for this site, we anticipate that USEPA and ADEQ will require an associated risk assessment to assure safe use of the site in accordance with the deed restrictions.

2. A DU needs to be developed to address the future worker scenario on the Site as mentioned in comment No.1. An upper confidence limit on the arithmetic mean needs to be developed for the DU sampling plan.

RESPONSE: See response to comment 1.

3. Figure 7 denotes an area which seems to be part of the site as a background area. Figure 5 shows that two samples C2 and C3 collected at the area bordering the proposed background area have dioxin soil level of between 5 ppb and 7.5 ppb. An appropriate background up-gradient from the Site need to be selected.

RESPONSE: We have revised the title of DU#1 as being an uncapped area of the site (Uncapped Area East), and have separated out from the former DU#1 area another uncapped area, new DU#6 (Uncapped Area West); both uncapped areas will be appropriately investigated for compliance with the dioxin soil screening level of 665 ppt TEQ. We do not anticipate collecting soil samples to define local background concentrations because we understand that this information is not relevant to determining compliance of the site under the query posed by the "dioxin reassessment."

4. The conceptual site model should include leaching of contaminants in soil into the groundwater. Evaluation of this pathway should be addressed.

RESPONSE: The leaching pathway has been included in the conceptual site model.

5. Table 1 provides dioxin levels in soil samples collected in 1995 and 2012. A factor of 0.78 was developed based on the 2012 samples to adjust TEFs from International TEFs to the WHO TEFs. In the risk assessment you should show the congeners for each dioxin sample and then apply the new WHO TEFs. Do not use a correction factor of 0.78.

RESPONSE: The correction factor approach was utilized because the congener-specific data corresponding to the post-remediation sampling completed in the mid-1990s was not available; only the TEQ values were reported in the available documents.

Cardno ChemRisk responses to comments from: Mark Moix, ADEQ

1. *Page 4, first paragraph: This paragraph states "Based on the current Site configuration, the only potential offsite transport pathway would be stormwater and associated sediment flowing down to the railroad ditch from overflow of the onsite drainage ditches during exceptionally heavy rain events". However the railroad ditch, which is likely a completed pathway for sediment transport, is not carried forward in the CSM as an offsite receptor point in either the text or on Figure 6. Please explain or include the railroad ditch as an offsite receptor point.*

RESPONSE: The railroad ditch has been included in the revised CSM.

2. *Page 4, last paragraph: Groundwater is not considered a completed pathway because "Likewise, the groundwater transport pathway is considered incomplete due to the insoluble nature of PCDD/Fs". Other than this general statement, no data are presented to support this. Additionally, existing data related to pentachlorophenol (PCP) in groundwater is requested. The Arkwood Remedial Investigation proposes that most of the groundwater from the site likely discharges through New Cricket Spring. Therefore, sampling of the spring should be conducted to evaluate the presence, if any, of dioxin in the groundwater. Additionally, the mechanisms of groundwater movement from the site should be evaluated to determine if a portion of the groundwater leaving the site bypasses New Cricket Spring and moves to other receptor points. Pathways to consider are presented in Attachment 1.*

RESPONSE: The groundwater/leaching transport pathway has been included in the revised CSM. The queries from USEPA under the "dioxin reassessment" of the Arkwood site apply solely to chlorinated dibenzo-p-dioxins and dibenzofurans, and the ongoing monitoring and treatment of groundwater pentachlorophenol are presently outside the scope of this CSM. A Supplemental Groundwater Tracing Study will be conducted to provide additional data about water movement from the site to New Cricket Spring.

3. *It is understood that evaluation of the rate and extent of contaminant transport in surface water and groundwater in areas of karst features is difficult; however, additional investigation is necessary to evaluate the potential pathways detailed above. The CSM could be updated with the methods noted below:*

RESPONSE: We understand that the query from USEPA under its "dioxin reassessment" of this site concerns site compliance with the 665 ppt TEQ dioxin soil screening level. Due to the very limited water solubility of dioxins and the groundwater filtration and ozonation treatment system operating continuously at New Cricket Spring, it is reasonable to expect that groundwater released from the treatment system will not cause contamination above the soil screening level. As stated under the response above, a Supplemental Groundwater Tracing Study will be conducted to provide additional data about water movement from the site to New Cricket Spring.

a. *Surface Geophysics - Geophysical technologies could be used to locate karst features in the subsurface. This information can be used to assist in locating additional groundwater monitoring wells. General types of surface geophysical tools are listed below. Subsurface/borehole geophysics are described in 3.c below.*
    i. *Gravity Survey*
    ii. *Refraction/Reflection Seismic Survey*
    iii. *Ground Penetrating Radar*
    iv. *Electromagnetic (EM) and Resistivity Survey*

b. *Tracer Study - The tracer survey conducted in 1992 should be expanded to further evaluate movement of contaminants in the groundwater away from the site. Neither of the two dye injection points used in the 1992 survey was near the location of the onsite sinkhole, which has been identified as one source of contamination on the site. It is recommended that an additional tracer survey be performed which uses as an injection site in the area near the on-site sinkhole.*
Positive detections of dye in rail road tunnel to the north of the Arkwood site confirm that groundwater flow from the site through the joint network within the limestone rock is occurring. The joint orientation is generally north-south, and these are likely to be primary conduits for groundwater within the karst formations at this location. The joints will also conduct contaminated groundwater in directions away from New Cricket Spring. These potential pathways should be evaluated.

c. *Shallow Monitoring Well samples*
Include geophysical logging to provide additional data concerning the location and orientation of joints, fractures and karst features. These data will aid in mapping subsurface permeability zones.

d. *Deep Monitoring Well samples*
    - *Include geophysical logging.*

e. *Water Supply Well samples*

f. *Spring Sampling*

g. *Surface Water· Preliminary water balance calculations indicate a significant difference (surplus) between net water input within the site catchment and measured discharge from New Cricket Spring, allowing for surface runoff and losses due to evaporation. The net differences (water unaccounted for) ranged from three to five times the volume being discharged at the spring. Even allowing for a margin of error in the preliminary calculations, the difference between estimated water input and output at the spring indicates that infiltration to groundwater is likely to be much greater than previously recognized. That being the case, there is a high probability that constituent contaminants entrained in groundwater flow will bypass New Cricket Spring. Any flow bypassing the spring will remain untreated within the karst system. It will migrate via interflow and* *eventually discharge at springs potentially some distance from the site. The following methods and data are suggested to evaluate the surface water pathways.*

i. *Install small weirs as necessary to measure surface water run-on and runoff to the site and to provide the real-time data via telemetry.*
ii. *Install or modify the weir at New Cricket Spring to measure continuous discharge from the spring and provide real-time telemetry.*
iii. *Prepare estimates of evaporation throughout each year for use in water balance calculations for the site.*
iv. *Obtain rainfall data from the nearest climate station for use in water balance calculations for the site.*

RESPONSE: The above considerations are likely to be unnecessary due to the limited potential for off-site release of dioxins in sediments via on-site drainage ditches and the limited solubility of dioxins in water. Sampling of the railroad ditch for dioxins will provide data relevant to confirming this expectation.

4. *Because of its size, Decision Unit (DU) #2 should be divided into three Decision Units (Attachment 2). Attached is a figure with a suggested option for the proposed division. The proposed division of DU2 is to correspond with the main functional areas within the former wood treating site. The division of DU2 also aligns with the clusters of 1995 analytical results outlined in Figure 5 of CSM attachments.*

RESPONSE: Per the suggestions of Deanna Crumbling from USEPA, the capped area (DU#2) that comprises about 82% of the site area will be divided into 44 quarter-acre sectors and 5 sectors will be randomly selected for composite sampling (30 subsamples each), plus one of the sectors will be sampled in triplicate for QC purposes.

5. *Currently, the deed notice for the site does not comply with the requirements set forth in the Record of Decision (ROD). As a result, the Site remedy is unprotected and completes potential pathways of exposure. Pending the appropriate deed restriction, the CSM should fully evaluate potential exposure for future residential use and construction worker scenarios. In addition, the ADEQ considers all waters in the State of Arkansas as having a domestic water supply use unless restricted; therefore, the on and off-site groundwater pathway must be fully evaluated.*

RESPONSE: The deed restrictions have been modified to assure compliance of site owners with the ROD. However, the CSM has been revised to include all possible pathways of exposure in regards to the queries of USEPA under the "dioxin reassessment."